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Design of a Permeable Reactive Barrier to retain Cs-137

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A Permeable Reactive Barrier has been designed to treat Cs-137 polluted groundwater. In order to check both reactivity and permeability, laboratory batch and column tests combined with reactive transport modeling have been performed. The trapping mechanism is based on the sorption of cesium on illite-containing clays. Batch experiments were conducted to obtain the partition coefficients (Kd) of different clay samples in solutions with different potassium concentration. The results were modeled with a cation-exchange model.
The permeability of the reactive material is provided by the dispersion of the clay on a matrix of wooden shavings. Constant head tests allowed obtaining permeability values. The mixture of wooden shavings and clay (2:1 by weight) is a material that has a hydraulic conductivity (10-4 m/s) high enough to ensure an adequate hydraulic performance for an eventual PRB excavated in many aquifers.
Several column experiments with different flow rates were conducted to confirm the Cs retention under different conditions. A blind 1D reactive transport model based on the cation-exchange model was able to predict reasonably well the results of column experiments.
The reactive transport model, validated with the column experiments, was used to investigate the performance and duration of 1m thick barrier under different scenarios (flow, clay proportion, Cs-137 and K concentration). As expected, the sensitivity tests proved that the retention capacity of dissolved Cs-137 in groundwater depends linearly on the amount of clay used in the filling material. As well, the operation time increases linearly when decreasing the flow rate. Finally, the concentration of potassium in inflow water has a remarkable and non-linear influence in the retention of Cs-137. Very high concentrations of potassium are the greatest threat and can lead to the infeasibility of the permeable reactive barrier. Due to the Cs-K competition, the barrier is comparatively more efficient to treat high concentrations of Cs-137.